OCR
Oxford Cambridge and RSA

Thursday 14 May 2015 – Morning

AS GCE MATHEMATICS (MEI)

4755/01 Further Concepts for Advanced Mathematics (FP1)

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4755/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

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- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **16** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

This paper has been pre modified for carrier language

Turn over

Section A (36 marks)

1 Given that $\mathbf{M}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 1 \\ 3 \end{pmatrix}$, where $\mathbf{M} = \begin{pmatrix} 4 & -3 \\ 8 & 21 \end{pmatrix}$, find x and y. **[6]**

2 Find the roots of the quadratic equation $z^2 - 4z + 13 = 0$.

Find the modulus and argument of each root. **[5]**

3 The equation $2x^3 + px^2 + qx + r = 0$ has a root at $x = 4$. The sum of the roots is 6 and the product of the roots is -10. Find p, q and r. **[6]**

4 Indicate, on a single Argand diagram

(i) the set of points for which $\arg(z - (-1 - \mathrm{j})) = \dfrac{\pi}{4}$, **[2]**

(ii) the set of points for which $|z - (1 + 2\mathrm{j})| = 2$, **[2]**

(iii) the set of points for which $|z - (1 + 2\mathrm{j})| \geqslant 2$ and $0 \leqslant \arg(z - (-1 - \mathrm{j})) \leqslant \dfrac{\pi}{4}$. **[2]**

5 **(i)** Show that $\sum_{r=1}^{n} (2r - 1) = n^2$. **[3]**

(ii) Show that $\dfrac{\sum_{r=1}^{n} (2r-1)}{\sum_{r=n+1}^{2n} (2r-1)} = k$, where k is a constant to be determined. **[4]**

6 A sequence is defined by $u_1 = 3$ and $u_{n+1} = 3u_n - 5$. Prove by induction that $u_n = \dfrac{3^{n-1} + 5}{2}$. **[6]**

Section B (36 marks)

7 A curve has equation $y = \dfrac{(3x+2)(x-3)}{(x-2)(x+1)}$.

(i) Write down the equations of the three asymptotes and the coordinates of the points where the curve crosses the axes. **[4]**

(ii) Sketch the curve, justifying how it approaches the horizontal asymptote. **[5]**

(iii) Find the set of values of x for which $y \geqslant 3$. **[3]**

8 The complex number 5 + 4j is denoted by α.

(i) Find α^2 and α^3, showing your working. **[3]**

(ii) The real numbers q and r are such that $\alpha^3 + q\alpha^2 + 11\alpha + r = 0$. Find q and r. **[4]**

Let $f(z) = z^3 + qz^2 + 11z + r$, where q and r are as in part **(ii)**.

(iii) Solve the equation $f(z) = 0$. **[3]**

(iv) Solve the equation $z^4 + qz^3 + 11z^2 + rz = z^3 + qz^2 + 11z + r$. **[2]**

9 The triangle ABC has vertices at $A(0,0)$, $B(0,2)$ and $C(4,1)$. The matrix $\begin{pmatrix} 1 & -2 \\ 3 & 0 \end{pmatrix}$ represents a transformation T.

(i) The transformation T maps triangle ABC onto triangle $A'B'C'$. Find the coordinates of A', B' and C'. **[3]**

Triangle $A'B'C'$ is now mapped onto triangle $A''B''C''$ using the matrix $\mathbf{M} = \begin{pmatrix} 4 & 0 \\ 0 & 2 \end{pmatrix}$.

(ii) Describe fully the transformation represented by **M**. **[3]**

(iii) Triangle $A''B''C''$ is now mapped back onto ABC by a single transformation. Find the matrix representing this transformation. **[3]**

(iv) Calculate the area of $A''B''C''$. **[3]**

END OF QUESTION PAPER

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Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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Section A (36 marks)

1	

2

3	

4 (i) & (ii) & (iii)	

5 (i)	

5 (ii)	

6

(answer space continued on next page)

6	(continued)

Section B (36 marks)

7 (i)	
7 (ii)	
	(answer space continued on next page)

7 (ii)	**(continued)**
7 (iii)	

8 (i)	
8 (ii)	

8 (iii)	
8 (iv)	

9 (i)	
9 (ii)	

9 (iii)	
9 (iv)	
	(answer space continued on next page)

9 (iv)	(continued)

Annotations and abbreviations

Annotation in scoris	**Meaning**
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

Subject-specific Marking Instructions for GCE Mathematics (MEI) Pure strand

a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more ‘method’ steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation ‘dep *’ is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be ‘follow through’. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

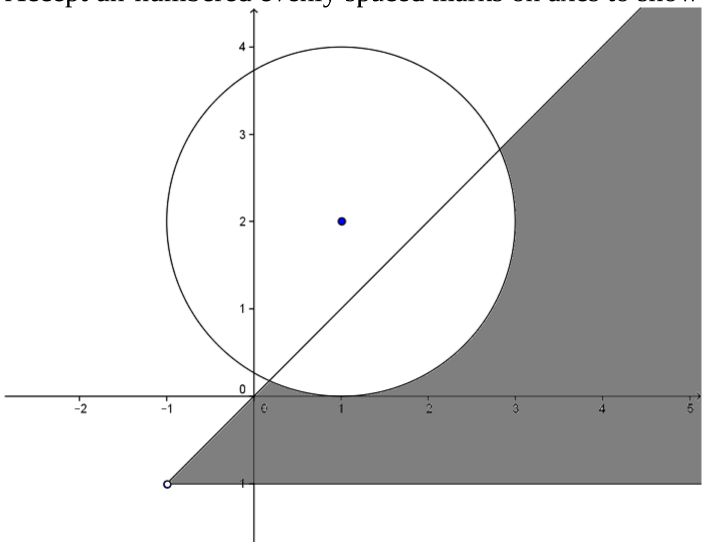
NB Follow these maths-specific instructions rather than those in the assessor handbook.

h For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

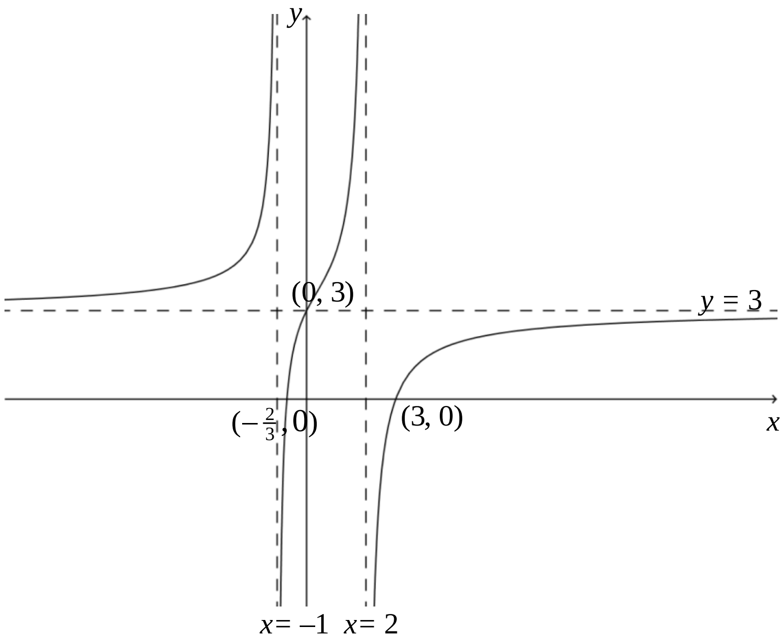
Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question			Answer	Marks	Guidance
1			$\mathbf{M}^{-1} = \frac{1}{108}\begin{pmatrix} 21 & 3 \\ -8 & 4 \end{pmatrix}$	M1* M1* A1	Attempt to find $\mathbf{M}^{-1}$ or $108\mathbf{M}^{-1}$ Divide by their determinant, Δ, at some stage Correct determinant, (A0 for det **M**= $\frac{1}{108}$ stated, all other marks are available)
			$\frac{1}{108}\begin{pmatrix} 21 & 3 \\ -8 & 4 \end{pmatrix}\begin{pmatrix} 1 \\ 3 \end{pmatrix} = \begin{pmatrix} \frac{5}{18} \\ \frac{1}{27} \end{pmatrix}$	M1 A1	Attempt to **pre**-multiply by inverse or by Δ $\mathbf{M}^{-1}$ Correct matrix multiplication (allow one slip)
			$x = \frac{5}{18},\ y = \frac{1}{27}$,oe	A1dep* **[6]**	For both, cao *x* and *y* must be specified, may be in column vectors **SC** answers only B1
		OR			
			$4x - 3y = 1$ $8x + 21y = 3$	M1 A1	Using **M** to create two equations Correct equations
			Eliminating *x* or *y*	M1	Any valid method
			Finding second unknown	M1	Valid method
			$x = \frac{5}{18}, y = \frac{1}{27}$ Allow 3 dp or better.	A1A1	For each cao. **SC** Answers only B1
				[6]	
2			$2 + 3\text{j}$ and $2 - 3\text{j}$	B1	For both, accept $2 \pm 3\text{j}$
			Modulus $= \sqrt{(2^2 + 3^2)} = \sqrt{13}$	M1	Attempt at modulus of their complex roots
			Argument $= \pm\arctan\left(\frac{3}{2}\right) = \pm 0.983$	M1	Attempt at $\arctan\left(\pm\frac{3}{2}\right)$ ft their complex roots
			$2 + 3\text{j}$ has modulus $\sqrt{13}$ and argument 0.983 $2 - 3\text{j}$ has modulus $\sqrt{13}$ and argument -0.983	A1ft A1ft **[5]**	Moduli specified, ft their roots. Accept √13 only ft their roots - must be in $(-\pi, \pi]$ Accept ±0.983, ±56.3° If 2 sf given accuracy MUST be stated.

Question			Answer	Marks	Guidance
3			$\frac{-p}{2}=6 \Rightarrow p=-12$	M1,M1	M1 use of $\sum\alpha$ for p and M1 use of $\alpha\beta\gamma$ for *r* - allow one sign error; 2 sign errors is M1 M0
			$\frac{-r}{2}=-10 \Rightarrow r=20$	A1 A1	for *p*, cao for *r*, cao
			OR $\alpha+\beta+4=6$, $4\alpha\beta = -10$	**OR**	
			Implies α,β satisfy $2x^2-4x-5=0$	M1	Valid method to create a quadratic equation
			Roots $1\pm\frac{\sqrt{14}}{2}$	M1	Attempt to solve a 3-term quadratic
			$-\frac{p}{2}=1+\frac{\sqrt{14}}{2}+1-\frac{\sqrt{14}}{2}+4=6 \Rightarrow p=-12$	A1	for *p*, cao
			Product of roots $=-10=-\frac{r}{2}\Rightarrow r=20$	A1	for *r*, cao
			THEN	**THEN**	
			EITHER $x=4$ is a root, so $2\times 64+16p+4q+r=0$	M1	Substitution and attempt to solve for coefficient of x^2,(or for the remaining unknown.) Allow making *q* the subject if *p* and *r* not found.
			OR $\alpha+\beta+4=6\Rightarrow\alpha+\beta=2$ $4\alpha\beta=-10\Rightarrow\alpha\beta=-\frac{10}{4}$ $\frac{q}{2}=4\alpha+4\beta+\alpha\beta=4\times 2-\frac{5}{2}$		OR M1 using $\sum\alpha\beta$ OR use of remainder after division
			$\Rightarrow q=11$	A1 **[6]**	for *q*, cao

Question			Answer	Marks	Guidance
4	(i)		Accept un-numbered evenly spaced marks on axes to show scale 	B1 B1 **[2]**	Line at acute angle, all or part in Im z>0 Half line from -1- j through 0 [don't penalise if point -1- j is included] Allow near miss to 0 if π/4 marked SC correct diagram, no annotations seen B1 B0
4	(ii)			B1 B1 **[2]**	Circle centre 1 + 2j Radius 2 Must touch real axis SC correct diagram, no annotations seen B1 B0
4	(iii)			B1 B1 **[2]**	The shaded region must be outside their circle and have a border with the circumference Fully correct SC correct diagram, no annotations seen allow B1 B1
5	(i)		$\sum_{r=1}^{n}(2r-1)=2\sum_{r=1}^{n}r-n$ $=n(n+1)-n = n^2$	M1 M1 A1 **[3]**	Attempt to split into two sums (May be implied) Use of standard result for Σr cao (must be in terms of n) SC Induction: B1 case $n = 1$: E1 sum to $k + 1$ terms correctly found : E1 argument completely correct
5	(ii)		$\frac{\sum_{r=1}^{n}(2r-1)}{\sum_{r=n+1}^{2n}(2r-1)}=\frac{n^2}{(2n)^2-n^2}$ $=\frac{n^2}{3n^2}=\frac{1}{3}=k$	M1 M1 A1 A1 **[4]**	Use of result from (i) in numerator of a fraction Expressing denominator as $\sum_{r=1}^{2n}....-\sum_{r=1}^{n}....$ need not be explicit, or other valid method. Correct sums $k=\frac{1}{3}$

Question			Answer	Marks	Guidance
6			$u_1 = 3$ and $\frac{3^{1-1}+5}{2} = 3$, so true for $n = 1$	B1	Must show working on given result with $n = 1$
			Assume true for $n = k$ $\Rightarrow u_k = \frac{3^{k-1}+5}{2}$	E1	Assuming true for k Allow "Let $n = k$ and (result)" "If $n = k$ and (result)" Do not allow " $n = k$" or "Let $n = k$", without the result quoted, followed by working
			$\Rightarrow u_{k+1} = 3\left(\frac{3^{k-1}+5}{2}\right) - 5$	M1	u_{k+1} with substitution of result for u_z and some working to follow
			$= \frac{3^k+15}{2} - 5$ $= \frac{3^k+15-10}{2}$ $= \frac{3^k+5}{2}$	A1	Correctly obtained
			$= \frac{3^{n-1}+5}{2}$ when $n = k+1$		Or target seen
			Therefore **if** true for $n = k$ it is **also true** for $n = k+1$.	E1	Both points explicit Dependent on A1 and previous E1
			Since it is true for $n = 1$, it is true for all positive integers, n.	E1 **[6]**	Dependent on B1 and previous E1
7	(i)		Asymptotes: $y = 3$, $x = 2$, $x = -1$	B1 B1	 (both) Allow $x = 2, -1$
			Crosses axes at $(0,\ 3)$	B1	Must see values for x and y if not written as co-ordinates
			$\left(\frac{-2}{3},\ 0\right)$, $(3,\ 0)$	B1	(both) Must see values for x and y if not written as co-ordinates.
				[4]	

Question			Answer	Marks	Guidance	
7	(ii)			B1	Intercepts labelled (single figures on axes suffice)	
				B1	Asymptotes correct and labelled. Allow y = 3 shown by intercept labelled at (0,3) and x = 2 and x = -1 likewise	
				B2	Three correct branches (-1 each error) Any poorly illustrated asymptotic approaches penalised once only.	
			When x is large and positive, graph approaches y = 3 from below, e.g. for x = 100, $\frac{302\times97}{98\times101}=2.9...$ When x is large and negative, graph approaches y = 3 from above, e.g. for x = -100, $\frac{-298\times-103}{-102\times-99}=3.03...$	B1 **[5]**	Approaches to y = 3 justified There must be a result for y	
7	(iii)		$y\geq3\Rightarrow 0\leq x<2$ or $x<-1$	B1 B1B1 **[3]**	$x<-1$ $0\leq x<2$ (B1 for $0 < x < 2$ or $0 \leq x \leq 2$) isw any more shown	

Question			Answer	Marks	Guidance	
8	(i)		$(5+4j)^2=(5+4j)(5+4j)=25+40j-16=9+40j$ $(5+4j)^3=-115+236j$	M1 A1 A1 **[3]**	Use of $j^2=-1$ at least once	
8	(ii)		$\alpha^3+q\alpha^2+11\alpha+r=0$ $\Rightarrow -115+236j+9q+40qj+55+44j+r=0$ $\Rightarrow (236+40q+44)j=0$, $-115+9q+55+r=0$ $\Rightarrow q=-7$ $\Rightarrow r=123$	 M1 M1 A1ft A1ft **[4]**	 Substitute for α Compare either real or imaginary parts $q=-7$ ft their α^2 and α^3 $r=123$ ft their α^2 and α^3	
8	(iii)		$f(z)=z^3-7z^2+11z+123$ Sum of roots $=7$ $\Rightarrow (5+4j)+(5-4j)+w=7$ $\Rightarrow w=-3$ Roots are $5+4j$ and $5-4j$ and -3	 M1 B1 A1 **[3]**	 Valid method for the third root. (division , factor theorem, attempt at linear x quadratic with complex roots correctly used) quoted cao real root identified, A0 if extra roots found	
8	(iv)		$zf(z)=f(z)\Rightarrow(z-1)f(z)=0$ $\Rightarrow z=1$ or $f(z)=0$ $\Rightarrow z=1,\ z=-3, z=5+4j, z=5-4j$	 M1 A1ft **[2]**	 solving $z-1=0$, **and** $f(z)=0$ (may be implied) For all four solutions [ft (iii)] NB incomplete method giving z = 1 only is M0 A0	

Question			Answer	Marks	Guidance
9	(i)		$\begin{pmatrix}1 & -2\\3 & 0\end{pmatrix}\begin{pmatrix}0 & 0 & 4\\0 & 2 & 1\end{pmatrix}$	M1	Any valid method – may be implied
			$=\begin{pmatrix}0 & -4 & 2\\0 & 0 & 12\end{pmatrix}$	A1	Correct position vectors found (need not be identified)
			$A' = (0, 0)$, $B' = (-4, 0)$, $C' = (2, 12)$	A1ft **[3]**	co-ordinates, ft their position vectors A', B', C' identifiable. Coordinates only, M1A0A1
9	(ii)		**M** represents a two-way stretch	B1	Stretch. (enlargement B0)
			factor 4 parallel to the *x* axis factor 2 parallel to the *y* axis	B1 B1 **[3]**	Directions indicated
9	(iii)		$\begin{pmatrix}4 & 0\\0 & 2\end{pmatrix}\begin{pmatrix}1 & -2\\3 & 0\end{pmatrix}$	M1	Attempt at MT in correct sequence
			$=\begin{pmatrix}4 & -8\\6 & 0\end{pmatrix}$ Represents the composite transformation T followed by M	A1	cao
			$\begin{pmatrix}4 & -8\\6 & 0\end{pmatrix}^{-1} = \frac{1}{48}\begin{pmatrix}0 & 8\\-6 & 4\end{pmatrix}$ represents the single transformation	A1 **[3]**	cao
		OR	$\frac{1}{6}\begin{pmatrix}0 & 2\\-3 & 1\end{pmatrix}$ $\frac{1}{8}\begin{pmatrix}2 & 0\\0 & 4\end{pmatrix} = \frac{1}{48}\begin{pmatrix}0 & 8\\-6 & 4\end{pmatrix}$	B1 M1 A1 **[3]**	for T^{-1} and M^{-1} correct for attempt at $T^{-1}M^{-1}$ cao
		OR	$\begin{pmatrix}0 & -16 & 8\\0 & 0 & 24\end{pmatrix}$ whence $\begin{pmatrix}a_{11} & a_{12}\\a_{21} & a_{22}\end{pmatrix}\begin{pmatrix}0 & -16 & 8\\0 & 0 & 24\end{pmatrix} = \begin{pmatrix}0 & 0 & 4\\0 & 2 & 1\end{pmatrix}$ $\Rightarrow \begin{pmatrix}a_{11} & a_{12}\\a_{21} & a_{22}\end{pmatrix} = \frac{1}{48}\begin{pmatrix}0 & 8\\-6 & 4\end{pmatrix}$	M1 A1 A1 **[3]**	Finding A'', B'' and C'' coordinates or position vectors For correct position vectors Inverse matrix correctly found

Question			Answer	Marks	Guidance
9	(iv)		Area scale factor = 48 Area of triangle ABC = 4 square units Area of triangle $A''B''C'' = 48\times$ area of triangle ABC $= 192$ (square units)	B1 M1 A1 **[3]**	 Using their "48" and their area of triangle ABC, correct triangle Or other valid method cao
		OR	Finding $A''B''C''$ (0,0) (-16, 0) (8, 24) and using them Finding the area of $A''B''C''$ Area of triangle $=192$ (square units)	B1 M1 A1	$A''B''C''$ may be in (iii) Any valid method attempted cao (possibly after rounding to 3 sf)

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4755 Further Concepts for Advanced Mathematics (FP1)

General Comments

The impression was of many candidates who had a good appreciation of the demands of the specification, but who were often lacking the insight, precision and attention to detail that would have earned the highest marks. It was evident that much good advice from previous years had been assimilated. Many scripts showed candidates with a pleasing ability to express their arguments in an easily readable form. In many instances, however, algebraic notation was often carelessly written and there were many lapses in some of the simplest manipulations. Candidates should take care to answer the questions posed in the notation that the question has used. At this level exact answers are to be preferred where possible, but rounding is acceptable with stated accuracy. When decimal fractions were written down, and there were few places that required them, very few candidates bothered to state the accuracy of the result. Most candidates found that they could answer in the time available, but avoidable errors in the final parts of the last question may have been due to the need to rush to finish.

Comments on Individual Questions:

Question 1

Most candidates found that this was a straightforward starter, and many gained full marks. There was a fairly even split between those who demonstrated thorough understanding of the matrix work of the specification, and those who formed simultaneous equations from the given matrix set-up. Correct solutions earned full marks by either method. On the whole the latter method produced rather more numerical errors. A few candidates showed confusion between the determinant of the matrix **M** and its reciprocal, but were, none the less, able to formulate the correct inverse. Some lost marks through failing to identify clearly the value of x and the value of y. Overall, this was a well-answered question.

Question 2

This was another well-answered question. Some candidates failed to obtain the correct roots of the equation, either through incorrect use of the quadratic formula (usually sign errors) or from a failure to take the square root of the discriminant correctly. Final answers hopefully specified both modulus and argument of each of the roots, without leaving the examiner to deduce anything. If answers were left in modulus-argument form, which was not requested, the candidate has not made clear their understanding of the two terms. Arguments expressed to only two significant figures without stating this were not rewarded, and it was disappointing that so few candidates bothered to state accuracy when giving 3 or more significant figures. Writing down all the figures on the calculator display is not “appropriate accuracy”, either.

Question 3

Many good responses were seen here, the best showing efficiency in quick and easy methods in finding *q*. There were many choices in how to proceed. A surprising number of candidates, however, failed to find p and r from the given information. The equation $-\frac{p}{2}=6$ often produced an answer of $p=-3$, and similarly $r=5$ was obtained. Other candidates were in quadratic mode and used ‘product of the roots = -10’ to find *q*, not *r*. A valid method for finding the remaining unknown gained M1.

Question 4

This question was well answered by many good candidates. Others found it difficult.

(i) Errors seen in drawing the half line included incorrect starting points (usually the Origin or the point 1+*j*), full lines rather than half lines, and lines which failed to cut the real axis at an appropriate angle.

(ii) Most candidates were able to draw the circle with the correct centre and radius, touching the real axis at $z = 1$. Some circles failed to reach the real axis. Some were centred at the Origin and a few elsewhere.

(iii) Several areas were shown bounded by the line but inside the circle. Of candidates who had successfully answered parts (i) and (ii), the most frequent error was to shade down to the real axis.

In several cases it was extremely difficult to see any shading due to poor image quality after scanning. On the whole, hatching rather than pencil "fill" shows up better.

Question 5

(i) This part usually achieved full marks. Writing the sum $\sum_{r=1}^{n} 1 = 1$ was, predictably, the common error. Some wilful blindness in obtaining the given result was then evident.

(ii) Many candidates failed to spot the easy method of finding the sum in the denominator, by subtracting the sum of the first *n* terms from the sum of 2*n* terms. The commonly seen erroneous result was ¼. Some found an answer that was in terms of *n* and hoped this was a constant. Very few approached the problem by treating the sum as a simple arithmetic series. A few candidates tried out some numerical values of *n* and found the correct result for *k*. This verification received one mark provided more than one value had been tested.

Question 6

Yet again the number of students who fail to follow the recipe for Induction is surprising.

The candidates split into four camps.

1) Those who understood the idea of induction and did this perfectly. Good work. This question was well answered by the majority of candidates who had learned the required argument and expressed it well.

2) Others who also had the precise wording for the start and the finish, and wrote this down even though they did not have a middle section that supported their final assertions.

3) The third group, who got as far showing the n=k+1 term is in the desired form and then failing to be precise about the final wording.

4) Lastly those who did not seem to understand induction at all. There were not many of these.

The first four marks were usually obtained, with some latitude allowed for different ways of expressing the assumption of "true for $n = k$", (not the same thing as "assume $n = k$ is true"). Apart from some candidates who believed that they were dealing with a series, the central passage of algebra was successfully done. However the number of students who lost the final two explanation marks is extremely disappointing since this point is raised every year.

The wording that is unarguably acceptable has been set out in the mark schemes for many years.

"If it is true when n=k it is also true when n=k+1.

Since it is true for n=1, it is true for all positive integers n."

Question 7

The graph sketching problem is usually a welcome one in Section B. Many candidates are confident of what to do and are able to draw a careful sketch, which shows all the required features of the curve clearly.

(i) It would be good if all candidates gave conventional co-ordinates, in brackets, as requested, for the points where the graph crossed the axes, rather than embedding the necessary values in their working. If the values of both *x* and *y* were not seen, the mark was forfeit. The equations of the asymptotes were usually correct. The expression $y \to 3$ is not an equation. Occasionally either co-ordinates or asymptotes were forgotten.

(ii) In justifying the manner of the curve's approach to the horizontal asymptote, the calculations shown for large positive and negative values of *x* should each have a numerical result, the argument is not complete without one and the examiners do not reach for calculators. Most curves were shown correctly with full annotation of intercepts and asymptotes. The point $(-\frac{2}{3}, 0)$ was not always labelled. Asymptotic approaches should be clearly shown.

(iii) The solutions to the inequality were usually correct, especially for $x < 1$. The second pair was sometimes marred by wrongly including both ends, or wrongly excluding both.

Question 8

In (i) only occasional slips in arithmetic were seen. This part was well done by nearly all candidates.

(ii) Substitution and equating the imaginary part to zero was usually successful in finding *q*. It may have been pressure of time that led to some slips here, with q = 7 instead of q = -7. Again, errors in arithmetic sometimes led to an incorrect *r.*

(iii) Some candidates did not see a simple route through this part of the question, and having discovered the real root by trial, went to the trouble of factorising the cubic and finding the complex roots again. Full marks did depend on correct answers in part (ii). Some candidates are uncertain as to the difference between a root and a factor.

(iv) A correct solution was very rare. Most candidates quoted z = 1 as the root, some gave z = 0. Only a handful of the best candidates went about solving the equation by understanding, if not showing, the complete factorisation.

Question 9

(i) This was well done, apart from those candidates who stopped with position vectors and did not give coordinates.

(ii) A two-way stretch should not be described as an enlargement, so several candidates lost one mark. There should be an indication that 4 and 2 are scale factors or multipliers. '4 in the x-direction', for example, is inadequate and candidates should be aware that these details need precise descriptions.

(iii) Those candidates who multiplied the matrices the correct way round had no difficulty in obtaining the correct inverse matrix. There were errors in sequence seen when T^{-1} and M^{-1} were used. The determinant of the combined transformation was often put down as 52. Some candidates tried to solve equations for an unknown matrix mapping A''B''C'' to ABC which was cumbersome as a method, and prone to mistakes.

(iv) This part seemed to be found surprisingly hard, but it may be that time pressure was preventing careful thinking.

Some knew that the determinant is the scale factor, and used it on the area of the initial triangle, but often came to grief by failing to obtain the area correctly. Diagrams often revealed B and C wrongly plotted.

Others tried to work out the area of the triangle having worked out its co-ordinates. Some candidates plotted these co-ordinates incorrectly. Some worked out the area using sine rule and cosine rule from their sketch, although “ ½ b x h” would have served perfectly well.

GCE Mathematics (MEI)

				Max Mark	a	b	c	d	e	u
4751	01	C1 – MEI Introduction to advanced mathematics (AS)	Raw	72	63	58	53	48	43	0
			UMS	100	80	70	60	50	40	0
4752	01	C2 – MEI Concepts for advanced mathematics (AS)	Raw	72	56	50	44	39	34	0
			UMS	100	80	70	60	50	40	0
4753	01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	56	51	46	41	36	0
4753	02	(C3) MEI Methods for Advanced Mathematics with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4753	82	(C3) MEI Methods for Advanced Mathematics with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4754	01	C4 – MEI Applications of advanced mathematics (A2)	Raw	90	74	67	60	54	48	0
			UMS	100	80	70	60	50	40	0
4755	01	FP1 – MEI Further concepts for advanced mathematics (AS)	Raw	72	62	57	53	49	45	0
			UMS	100	80	70	60	50	40	0
4756	01	FP2 – MEI Further methods for advanced mathematics (A2)	Raw	72	65	58	52	46	40	0
			UMS	100	80	70	60	50	40	0
4757	01	FP3 – MEI Further applications of advanced mathematics (A2)	Raw	72	59	52	46	40	34	0
			UMS	100	80	70	60	50	40	0
4758	01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	57	51	45	38	0
4758	02	(DE) MEI Differential Equations with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4758	82	(DE) MEI Differential Equations with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4761	01	M1 – MEI Mechanics 1 (AS)	Raw	72	62	54	46	39	32	0
			UMS	100	80	70	60	50	40	0
4762	01	M2 – MEI Mechanics 2 (A2)	Raw	72	54	47	40	33	27	0
			UMS	100	80	70	60	50	40	0
4763	01	M3 – MEI Mechanics 3 (A2)	Raw	72	64	56	48	41	34	0
			UMS	100	80	70	60	50	40	0
4764	01	M4 – MEI Mechanics 4 (A2)	Raw	72	53	45	38	31	24	0
			UMS	100	80	70	60	50	40	0
4766	01	S1 – MEI Statistics 1 (AS)	Raw	72	61	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
4767	01	S2 – MEI Statistics 2 (A2)	Raw	72	65	60	55	50	46	0
			UMS	100	80	70	60	50	40	0
4768	01	S3 – MEI Statistics 3 (A2)	Raw	72	64	58	52	47	42	0
			UMS	100	80	70	60	50	40	0
4769	01	S4 – MEI Statistics 4 (A2)	Raw	72	56	49	42	35	28	0
			UMS	100	80	70	60	50	40	0
4771	01	D1 – MEI Decision mathematics 1 (AS)	Raw	72	56	51	46	41	37	0
			UMS	100	80	70	60	50	40	0
4772	01	D2 – MEI Decision mathematics 2 (A2)	Raw	72	54	49	44	39	34	0
			UMS	100	80	70	60	50	40	0
4773	01	DC – MEI Decision mathematics computation (A2)	Raw	72	46	40	34	29	24	0
			UMS	100	80	70	60	50	40	0
4776	01	(NM) MEI Numerical Methods with Coursework: Written Paper	Raw	72	56	50	45	40	34	0
4776	02	(NM) MEI Numerical Methods with Coursework: Coursework	Raw	18	14	12	10	8	7	0
4776	82	(NM) MEI Numerical Methods with Coursework: Carried Forward Coursework Mark	Raw	18	14	12	10	8	7	0
			UMS	100	80	70	60	50	40	0
4777	01	NC – MEI Numerical computation (A2)	Raw	72	55	47	39	32	25	0
			UMS	100	80	70	60	50	40	0
4798	01	FPT - Further pure mathematics with technology (A2)	Raw	72	57	49	41	33	26	0
			UMS	100	80	70	60	50	40	0

GCE Statistics (MEI)

			Max Mark	a	b	c	d	e	u
G241	01 Statistics 1 MEI (Z1)	Raw	72	61	54	47	41	35	0
		UMS	100	80	70	60	50	40	0
G242	01 Statistics 2 MEI (Z2)	Raw	72	55	48	41	34	27	0
		UMS	100	80	70	60	50	40	0
G243	01 Statistics 3 MEI (Z3)	Raw	72	56	48	41	34	27	0
		UMS	100	80	70	60	50	40	0

GCE Quantitative Methods (MEI)

			Max Mark	a	b	c	d	e	u
G244	01 Introduction to Quantitative Methods MEI	Raw	72	58	50	43	36	28	0
G244	02 Introduction to Quantitative Methods MEI	Raw	18	14	12	10	8	7	0
		UMS	100	80	70	60	50	40	0
G245	01 Statistics 1 MEI	Raw	72	61	54	47	41	35	0
		UMS	100	80	70	60	50	40	0
G246	01 Decision 1 MEI	Raw	72	56	51	46	41	37	0
		UMS	100	80	70	60	50	40	0